UNITED STATES PATENT APPLICATION

OF

Seung Kiu LEE

FOR

PROJECTING OPTICAL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Application No. P2003-08898, filed on February 12, 2003, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a projector, and more particularly, to a projecting optical system.

Discussion of the Related Art

[0003] In recent years, a projector is popularized and various forms of projectors are manufactured. The projector is divided into a product with light intensity applicable to a small screen and another product with the light intensity applicable to a large conference room or a theatre. And also the projector divided into a projector in a small portable size and a projector in a large size according to a purpose or use has various characteristics.

[0004] A display device employed for the projector is divided into an LCD (Liquid Crystal Display) panel and a DMD (Digital Micromirror Device) panel. Particularly in recent years, a plurality of projectors using the DMD panel widely used is manufactured. The projector using the DMD panel is normally called DLP (Digital Light Processing).

[0005] DMD used for the DLP projector includes a plurality of little micromirrors in a square form as a pixel and is horizontally/vertically arranged. Tilting each micromirror is performed by an electrical signal from outside around an axis of a diagonal line.

[0006] Therefore, when a light is received to the DMD, an angle of the light reflected is changed by tilting the micromirrors. In this case, the angle of the light formed by tilting the micromirrors is not continuously changed, and the micromirrors are tilted in only two directions such that a direction of the light is controlled using the micromirrors.

[0007] In this case, the micromirrors in the DMD is tilted in a diagonal direction of the micromirrors, and the light brought to incidence from outside needs to incidence in a direction at an angle of 45° to the diagonal line. The projecting optical system to be described below in accordance with a related art includes a TIR prism or mirror manufactured to be tilted by the electrical signal from outside such that the light brought to incidence on the TIR prism or mirror is at an angle of 45° to the diagonal line. Therefore, there is a problem in making the projector in a small size. This will be described in more detail referring to appended drawings.

[0008] FIG. 1 illustrates bird-eye view showing a projecting optical system in accordance with a related art. FIG. 2 illustrates a side view of a projecting optical system in accordance with a related art.

[0009] As illustrated in FIG. 1 and FIG. 2, the projecting optical system includes a lamp 101 for generating light, a color divider 102 for transmitting a particular wave of light, a illumination mixer 103 for receiving transmitted light and equally distributing the luminosity, a first illumination lens 104 and a second illumination lens 105 for controlling the luminosity, a first mirror 106 and a second mirror 107 for changing the direction of light, a TIR prism 108 for changing the angle of light to a particular angle, a DMD panel 109 for controlling light and darkness of an image by tilting the micromirror (not illustrated) using, and a projecting lens 110

for receiving light reflected by the DMD panel 109 and projecting the light in a predetermined size.

[0010] The projecting optical system composed as aforementioned in accordance with the related art will be described. First, the lamp 101 irradiates light through a bulb forming light and a reflective mirror reflecting light. Then the light irradiated from the lamp 101 is divided into a plurality of colors according to time by a rotation of the color divider 103 and incident on the illumination mixer 103. In this case, the color divider 102 includes a plurality of filters for transmitting or reflecting only a particular colors (red, green, blue) with the particular wave, and rotatably provided to a motor.

[0011] The illumination mixer 103 maintains luminosity on an emission plane although luminosity of light brought to incidence on an incidence plane is not equal. Accordingly, the emission plane performs a role of a plane light source.

[0012] The light equally irradiated as aforementioned is incident on the DMD panel 109 by the first lens 104 and the second lens 105. However, the light incident on the DMD panel 109 needs to have a predetermined angle. Desirably, the light should be brought to incidence on the DMD panel 109 in a direction at 45° to the diagonal line.

[0013] To be parallel with an axis of a projecting lens 110, the angle of the light incident on the DMD panel 109 in a normal direction also needs to be a predetermined angle. Therefore, in a structure of an illumination optical system, as illustrated in FIG. 1 and FIG. 2, the first mirror 106 and the second mirror 107 are provided between the illumination lens 104 and the second illumination lens 105. The direction of the light is changed to upward and downward for irradiating the light in a diagonal direction of the micromirror corresponding to the pixel of the

DMD panel108. As a result, the TIR prism 108 is also provided in a direction inclined by 45° to the diagonal line of the pixel for transmitting or reflecting light according to a characteristic of the incident angle of light.

[0014] Therefore, light incident on the DMD panel in a predetermined direction at a predetermined angle is inclined to an angle enabling light indent on the projecting lens 110 or in an opposite direction by the electrical signal from outside so as to create a division of light and darkness on the screen.

[0015] In the case, as illustrated in FIG. 2, there is a problem in making the projecting optical system in a small size because a channel of the light needs to be moved to a greatly high portion and the height of the projecting optical system can not be lowered for bringing the light incident on the second illumination lens 105 at a top portion of the TIR prism inclined 45°.

SUMMARY OF THE INVENTION

[0016] Accordingly, the present invention is directed to a projecting optical system that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0017] An object of the present invention is to provide a projecting optical system for reducing a height of all optical system.

[0018] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the

invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0019] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a projecting optical system includes a lamp for irradiating light, a color divider for dividing colors of light irradiated from the lamp, a illumination mixer for irradiating the light with equal light intensity, a channel-changing prism for changing a channel of light irradiated from the illumination mixer to upward and downward, and a TIR prism for changing a direction and angle of light to a predetermined direction and angle.

[0020] In this case, the channel-changing prism is rotatably provided for controlling step difference of incidence light. A reflective mirror is further included for changing the channel of light such that the light irradiated from the lamp is entered into the color divider. The channel-changing prism includes a distance between an axis of incidence light and an axis of emission light. The channel-changing prism is rotatably provided for controlling the step difference of emission light.

[0021] The TIR prism is inclined at a predetermined angle vertically and horizontally for maintaining the predetermined incidence angle of light required by the DMD panel.

[0022] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings;

[0024] FIG. 1 illustrates a bird-eye view of a projecting optical system in accordance with a related art.

[0025] FIG. 2 illustrates a side view of a projecting optical system in accordance with a related art.

[0026] FIG. 3 illustrates a bird-eye view of a projecting optical system in accordance with the present invention.

[0027] FIG. 4 illustrates a side view of a projecting optical system in accordance with the present invention.

[0028] FIG. 5 illustrates a diagram showing an operating principle of a channel-changing prism in a projecting optical system in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0029] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0030] FIG. 3 illustrates a bird-eye view of a projecting optical system in accordance with the present invention. FIG. 4 illustrates a side view of a projecting optical system in accordance with the present invention.

[0031] As illustrated in FIG. 3 and FIG. 4, the projecting optical system includes a lamp 301 having a bulb for generating light and a reflective mirror (not shown) for reflecting light, a color divider 302 for dividing colors of light according to time by rotating the light irradiated from the lamp 301, an illumination mixer 303 for mixing light received and irradiated from the color divider 302, of which luminosity is unevenly distributed, by reflecting the light therein so as to irradiate light of which luminosity is evenly distributed luminosity, a channel-changing prism 304 for changing the channel of light equally irradiated from the illumination mixer 303, and a TIR prism 306 for changing and irradiating the light irradiated from the channel-changing prism 304 in a predetermined direction at a predetermined angle.

[0032] In this case, the channel of the light from the lamp 301 is changed and entered into the color divider 302 or directly entered into the color divider by removing the reflective mirror 307.

[0033] The light from the illumination mixer 303 is passed through the first illumination lens 308, the channel-changing prism 304 and the second illumination lens 309, and entered into the DMD panel 305.

[0034] In this case, the first and second lens 308 and 309 includes at least one lens and the axes of light between the first and second lens are not corresponded with each other.

[0035] However, the channel-changing prism 304 is provided between the first illumination lens 308 and the second illumination lens 309 for keeping a predetermined distance (height difference of the light channel) between the axes.

[0036] The projecting optical system configured as aforementioned in a thin layer form according to the present invention will now be described in more detail referring to appended drawings.

[0037] First, the light entered into the color divider 302 through the lamp 301 is orderly divided through the rotation of the color divider 302 and entered into the illumination mixer 303. The illumination mixer 303 maintains luminosity on the emission plane although luminosity of light brought to incidence on the incidence plane is not equal. Accordingly, the emission plane performs the role of the plane light source.

[0038] The light irradiated from the illumination mixer 303 is entered into the DMD panel 305 by the first illumination lens 308 and the second lens 309. The first illumination lens 308 includes at least one lens and the second illumination lens 309 includes at least one lens.

[0039] In this case, the axes of light between the first illumination lens 308 and the second lens illumination lens 309 are not corresponded with each other. However, the channel-changing prism 304 is provided between the first illumination lens 308 and the second illumination lens 309 for keeping a predetermined distance (height difference of the light channel) between the axes.

[0040] As illustrated in FIG. 5, the channel-changing prism 304 changes the channel of light incident on the incidence plane (S1) by a reflective plane (S2), and reflected again by another reflective plane (S3) so as to pass the emission plane (S4).

[0041] The channel-changing prism 304 is in a complete quadrilateral form, and the axis of the incidence light is at a predetermined distance from the axis of the emission light. Accordingly, the predetermined distance is formed in a vertical direction by the rotation of the channel-changing prism so as to perform an importance role for changing the channel of light.

[0042] The light emitted from the first illumination lens 308 has a particular the step difference for vertical and horizontal directions by the channel-changing prism 304, and entered into the TIR prism 306 having a characteristic selectively transmitting or reflecting the light according to the angle at which the light is entered after passing through the second illumination lens 309.

[0043] The TIR prism 306 has a particular angle for vertical and horizontal directions and a characteristic for maintaining the incidence direction and angle of light required by the DMD panel 305.

[0044] As aforementioned, the light incident on the DMD panel 305 is reflected from the TIR prism 306 through tilting the micromirrors according to the external electrical signal so as to display light and darkness on the screen (not shown) by entering into the projecting lens 310 or not.

[0045] Referring to the side view of the projecting optical system in accordance with the present invention in FIG. 4, being different from the prior art in FIG. 2, the TIR prism 306 does not need to be rotated for maintaining the predetermined incidence direction on the DMD panel nor need to be provided at a same location of the second mirror 107 illustrated in FIG. 2. Therefore, the height H of the projecting optical system illustrated in FIG. 4 is lower than the height h of the projecting optical system illustrated in FIG. 2

[0046] As another embodiment of the present invention, the color divider 302 is not provided between the lamp 301 and the illumination mixer 303 but between the illumination mixer 303 and the first illumination lens 308.

[0047] The projecting optical system as aforementioned has a following effects. First, a projector in a thin size can be manufactured because the height of the projecting optical system using the DMD panel can be reduced and has an effect of portability. Second, there is an effect of reducing the height of a set by applying to not only the projector but also the projection TV.

[0048] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.